Elevator Mini Lab – Formative Assessment (Newton's 2nd Law)

https://interactives.ck12.org/simulations/physics/elevator/app/index.html?screen=sandbox

PURPOSE: To find how your apparent weight (as measured by a bathroom scale) changes when you ride up and down in an elevator and to determine the values of the elevator's accelerations.

HYPOTHESIS: Compared to your normal weight, what will a bathroom scale read when you:

a. start going up from the bottom floor?
b. go up at constant velocity between floors?
c. are slowing before you stop at the top floor?
d. start going down from the top floor?
e. go down at constant velocity between floors?
f. are slowing before you stop at the bottom floor?

Explain your hypotheses.

PROCEDURE:

1. Open the simulation at the URL at the top of the first page.
2. Leave the mass and acceleration at the default settings. (m = 40.0 kg, a = low).
3. Click the button to move the floor 2. Observe the normal force readings as you go up (let the elevator go until it stops). If you were standing on a bathroom scale, this is what it would read as you move up. Record the normal force readings in the data table.
4. What is happening to the velocity at each of these readings (zero, increasing, decreasing or staying the same)? Look at the velocity graph. Record these observations.
5. Determine the direction of the instantaneous velocity and accelerations for each part of the elevator's motion. (up is + and down is -). Remember, the sign of the acceleration can be determined from the slope of the velocity graph.
6. Print your graphs by printing the web page or taking a screenshot and pasting it into a google doc to print.
7. Draw quantitative (with numerical values for forces) free-body diagrams using agent-object notation for a 40.0 kg person standing on the scale during the first, middle and last portions of the elevator's trip. *Note: The normal force is equal to the scale reading. Remember that the weight or force of gravity is given by W=mg. This simulation rounds off g to 10 m/s^2.*
8. Repeat steps #3-6 for an elevator going down from floor 2 to floor 0.

DATA:

Elevator is going up.

m = 40.0 kg
a = Low
scale reading at rest = __________ N

scale reading (N) (when going up)	**velocity** (increasing, staying the same, decreasing)	**vel. direction** (up or down)	**acc. direction** (up , down, or N/A)

Quantitative Free-body diagrams (include a vector next to the freebody diagram showing the direction of the acceleration if applicable, put numbers next to your vectors):

first part of trip up: middle part of trip up: last part of trip up:

DATA:

Elevator is going down.

m = 40.0 kg
a = Low
scale reading at rest = __________ N

scale reading (N) (when going down)	**velocity** (increasing, staying the same, decreasing)	**vel. direction** (up or down)	**acc. direction** (up , down, or N/A)

Quantitative Free-body diagrams (include a vector next to the freebody diagram showing the direction of the acceleration if applicable, put numbers next to your vectors):

first part of trip down: middle part of trip down: last part of trip down:

DATA ANALYSIS: (Show one of each type of calculation).

1. For each of your 6 free-body diagrams, calculate the net force.
2. Using Newton's 2nd law ($F_{net} = ma$), calculate the acceleration in each case (don't forget the sign, + or –).
3. Check your answer for acceleration by calculating the accelerations from the slopes of the velocity graphs.

Calculations:

elevator motion	**F_{net} (N)**	**acceleration (m/s^2)**
first part of trip up		
middle part of trip up		
last part of trip up		
first part of trip down		
middle part of trip down		
last part of trip down		

CONCLUSIONS/EXTENSIONS

1. Do your findings support your hypotheses? Explain.

2. The scale measures the normal force you exert on it (or vice versa). Does your actual weight change as you ride an elevator? Does the scale read your actual or apparent weight? Explain.

3. In what parts of the trip up and down was the acceleration of the elevator up? Did the scale read greater than, less than or equal to your actual weight?

4. In what parts of the trip up and down was the acceleration pointing down? Did the scale read greater than, less than or equal to your actual weight?

5. In what parts of the trip up and down was the acceleration zero? Did the scale read greater than, less than or equal to your actual weight?

6. A 75.0 kg person rides up and down in an elevator that starts from rest, accelerates from rest to 2.0m/s in 2.0s, continues at a constant velocity of 2.0m/s for 2.0s, and then comes to a stop from 2.0m/s in 2.0s. Calculate what the scale would read in each of the following situations. Show all work including free-body diagrams. Round off g to 10 m/s^2.

elevator motion	**scale reading (N)**
first part of trip up	
middle part of trip up	
last part of trip up	
first part of trip down	
middle part of trip down	
last part of trip down	

7. Go back to the simulation and change the mass to 75.0 kg and the acceleration to the maximum (high). Run the simulation and check your answers. If you got them wrong, try again until you get them right!